Chemistry (Theory) – Code 043

CBSE Class 12 Board Examination 2027 – Practice Paper No. 1

Practice Question Paper

Time: 3 hours **Max. Marks: 70**

(1) There are 33 questions in this question paper with internal choice.
(2) SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
(3) SECTION B consists of 5 very short answer questions carrying 2 marks each.
(4) SECTION C consists of 7 short answer questions carrying 3 marks each.
(5) SECTION D consists of 2 case-based questions carrying 4 marks each.
(6) SECTION E consists of 3 long answer questions carrying 5 marks each.
(7) All questions are compulsory.
(8) Use of log tables and calculators is not allowed.

SECTION A Questions 1 to 16 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions. **[16]**

1 Which of the following aqueous solutions will have the **lowest** freezing point? (Assume complete dissociation of all electrolytes.)

(A) 0.30 m glucose
(B) 0.10 m KNO_3
(C) 0.12 m $CaCl_2$
(D) 0.05 m $Al_2(SO_4)_3$

2 On hot May afternoons, fish in a shallow village pond come up to the surface and gulp air. Which statement best explains this?

(A) K_H of O_2 increases with rise in temperature, so the solubility of O_2 in water decreases.
(B) K_H of O_2 decreases with rise in temperature, so the solubility of O_2 in water increases.
(C) The vapour pressure of water decreases on heating, which removes dissolved O_2.
(D) Dissolved O_2 reacts with warm water to form H_2O_2.

3 How many faradays of electricity are required to reduce 0.5 mol of MnO_4^- ions to MnO_2 in neutral or faintly alkaline medium?

(A) 0.5 F
(B) 1.5 F
(C) 2.5 F
(D) 3.0 F

4 For the reaction A + B → Products, doubling [A] (with [B] constant) makes the initial rate four times. Doubling [B] (with [A] constant) leaves the rate unchanged. The rate law is:

(A) Rate = k[A][B]
(B) Rate = $k[A]^2$
(C) Rate = $k[A]^2[B]$
(D) Rate = $k[A][B]^2$

5 Which of the following ions is expected to form colourless compounds? (Atomic numbers: Ti = 22, Cr = 24, Ni = 28, Cu = 29)

(A) Ni^{2+}
(B) Cr^{3+}
(C) Ti^{4+}
(D) Cu^{2+}

6 Which of the following complexes can show geometrical (cis–trans) isomerism?

(A) $[Pd(NH_3)_2Cl_2]$
(B) $[Zn(NH_3)_2Cl_2]$
(C) $[Co(NH_3)_5Br]^{2+}$
(D) $[Ni(CO)_4]$

7 The number of unpaired electrons in the octahedral complex ion $[Fe(H_2O)_6]^{3+}$ is (Fe: Z = 26):

(A) 1 (B) 3

(C) 4 (D) 5

8 Which of the following isomers of $C_6H_{13}Br$ will undergo S_N1 reaction fastest?

(A) 1-Bromohexane (B) 3-Bromo-3-methylpentane

(C) 2-Bromohexane (D) 1-Bromo-2-methylpentane

9 Which of the following alcohols gives turbidity **immediately** with Lucas reagent at room temperature?

(A) Butan-1-ol (B) Butan-2-ol

(C) 2-Methylpropan-1-ol (D) 2-Methylpropan-2-ol

10 The correct order of **increasing** acidic strength is:

(A) ethanol < p-cresol < phenol < p-nitrophenol (B) p-cresol < ethanol < phenol < p-nitrophenol

(C) ethanol < phenol < p-cresol < p-nitrophenol (D) phenol < ethanol < p-cresol < p-nitrophenol

11 Sugar made from sugarcane in Maharashtra's sugar factories is sucrose. In sucrose the glycosidic linkage is between:

(A) C1 of α-D-glucose and C4 of another α-D-glucose (B) C1 of β-D-galactose and C4 of β-D-glucose

(C) C1 of α-D-glucose and C2 of β-D-fructose (D) C1 of β-D-glucose and C4 of another β-D-glucose

12 The major product of hydroboration–oxidation of 2-methylpropene, $(CH_3)_2C{=}CH_2$, is:

(A) 2-Methylpropan-2-ol (B) 2-Methylpropan-1-ol

(C) Butan-1-ol (D) Butan-2-ol

13 **Assertion (A):** A mixture of ethanol and water containing about 95% ethanol by volume cannot be separated into its pure components by fractional distillation.
Reason (R): Ethanol and water form a maximum boiling azeotrope.
Select the most appropriate answer from the options given below:

(A) Both A and R are true, and R is the correct explanation of A. (B) Both A and R are true, but R is not the correct explanation of A.

(C) A is true but R is false. (D) A is false but R is true.

14 **Assertion (A):** The half-life of a zero order reaction is independent of the initial concentration of the reactant.
Reason (R): For a first order reaction, $t_{1/2} = 0.693/k$.
Select the most appropriate answer from the options given below:

(A) Both A and R are true, and R is the correct explanation of A. (B) Both A and R are true, but R is not the correct explanation of A.

(C) A is true but R is false. (D) A is false but R is true.

15 **Assertion (A):** Zinc, cadmium and mercury are not regarded as transition metals.
Reason (R): These metals have completely filled d orbitals in their ground state as well as in their common oxidation states.
Select the most appropriate answer from the options given below:

(A) Both A and R are true, and R is the correct explanation of A. (B) Both A and R are true, but R is not the correct explanation of A.

(C) A is true but R is false. (D) A is false but R is true.

16 **Assertion (A):** Methanamine is a stronger base than ammonia in aqueous solution.
Reason (R): Methanamine gives a foul-smelling isocyanide when heated with chloroform and ethanolic KOH.
Select the most appropriate answer from the options given below:
(A) Both A and R are true, and R is the correct explanation of A.
(B) Both A and R are true, but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

SECTION B Questions 17 to 21 are very short answer questions carrying 2 marks each. **[10]**

17 (A) (I) Complete and balance the following ionic equation:
$MnO_4^- + H_2S + H^+ \rightarrow$
(II) The spin-only magnetic moment of a divalent ion of a first-row transition metal is 4.90 BM. Which one of Mn^{2+} (Z = 25), Fe^{2+} (Z = 26) and Ni^{2+} (Z = 28) is it? Show your working.
OR
(B) (I) Actinoids show a much wider range of oxidation states than lanthanoids. Give reason.
(II) Complete and balance the following ionic equation:
$Cr_2O_7^{2-} + Sn^{2+} + H^+ \rightarrow$

18 The active ingredient of an antibiotic syrup decomposes at 25 °C by first order kinetics. The rate constant is 4.606×10^{-3} day^{-1}.
(I) How many days will it take for the concentration of the active ingredient to fall to one-tenth of its initial value?
(II) How many days will it take for 75% of the active ingredient to decompose? (Given: log 2 = 0.301)

19 (I) When an egg is boiled, the clear liquid white becomes an opaque white solid. Name the process. Which level of protein structure remains intact in this change?
(II) Write the structure of the dipeptide alanylglycine (Ala–Gly) and mark the peptide linkage in it. (Alanine: $H_2N–CH(CH_3)–COOH$; glycine: $H_2N–CH_2–COOH$)

20 (I) Which of chlorobenzene and benzyl chloride ($C_6H_5CH_2Cl$) is hydrolysed more readily by aqueous NaOH? Give reason and write the equation.
(II) Optically active 3-chloro-3-methylhexane is hydrolysed in aqueous acetone. The product shows no optical rotation. Explain.

21 (I) Give a chemical test to distinguish between the isomeric amines propan-1-amine and N,N-dimethylmethanamine. Write the chemical equation.
(II) Why is the temperature kept between 273 K and 278 K during the diazotisation of aniline?

SECTION C Questions 22 to 28 are short answer questions carrying 3 marks each. **[21]**

22 Consider the cell at 298 K: Fe(s) | Fe^{2+}(0.001 M) || Cu^{2+}(0.1 M) | Cu(s)
Given: $E°(Fe^{2+}/Fe) = -0.44$ V, $E°(Cu^{2+}/Cu) = +0.34$ V, F = 96500 C mol^{-1}, 2.303RT/F = 0.059 V.
(I) Write the cell reaction.
(II) Calculate the emf of the cell.
(III) Calculate Δ_rG for the cell reaction.

23 (I) The rate constant of the first order decomposition of a pesticide residue in soil is 1.5×10^{-4} s^{-1} at 300 K and 1.5×10^{-3} s^{-1} at 330 K. Calculate the activation energy of the reaction. (R = 8.314 J K^{-1} mol^{-1})
(II) State the effect of a catalyst on (a) the activation energy and (b) the Gibbs energy change (ΔG) of a reaction.

24 Account for the following:

(I) The atomic radii of zirconium (160 pm) and hafnium (159 pm) are almost the same.

(II) In aqueous solution Ce^{4+} is a strong oxidising agent, whereas Eu^{2+} is a strong reducing agent.

(III) The $E°(M^{2+}/M)$ values of Mn, Ni and Zn are more negative than expected from the general trend in the first transition series.

25 An optically active alkyl bromide A, C_4H_9Br, reacts with aqueous NaOH by the S_N2 mechanism to give an alcohol B. When A is heated with alcoholic KOH, the major product is an alkene C. When A is heated with sodium metal in dry ether, it gives a hydrocarbon D, C_8H_{18}.

(I) Identify A and write the S_N2 mechanism for its conversion into B, showing the configuration of the product.

(II) Write the equations for the formation of C and D and give their IUPAC names.

26 An organic compound X ($C_8H_{10}O$) is insoluble in aqueous NaOH and does not react with sodium metal. On heating with HI, X gives two products Y and Z. Y dissolves in aqueous NaOH but not in aqueous $NaHCO_3$, and gives a white precipitate ($C_6H_3Br_3O$) with bromine water. Z on warming with aqueous KOH gives ethanol.

Identify X, Y and Z and write the equations involved. Why does X give Y and Z, and not iodobenzene and ethanol, with HI?

27 (A) Identify the name reaction and write the missing product in each:

(I) $CH_3CH_2COCl + H_2 \xrightarrow{-(Pd-BaSO_4)} ?$

(II) $C_6H_5COCH_3 \xrightarrow{-(Zn-Hg,\ conc.\ HCl)} ?$

(III) $CH_3CH_2CH_2COOH \xrightarrow{-((i)\ Br_2/red\ phosphorus,\ (ii)\ H_2O)} ?$

OR

(B) (I) Propanoic acid (molar mass 74 g mol^{-1}) boils at 414 K, whereas butan-1-ol (molar mass 74 g mol^{-1}) boils at 391 K. Explain.

(II) Give a simple chemical test to distinguish between ethanal and ethanoic acid.

(III) Why does benzoic acid not undergo Friedel–Crafts reaction?

28 Write chemical equations to carry out the following conversions:

(I) Propanamide to ethanamine

(II) Aniline to iodobenzene

(III) Benzenediazonium chloride to p-hydroxyazobenzene

SECTION D Questions 29 and 30 are case-based questions carrying 4 marks each. **[8]**

29 Reverse osmosis for drinking water

Many coastal villages in the Konkan region use small reverse osmosis (RO) plants to make drinking water from salty well water. Osmotic pressure (π) is a colligative property. For a dilute solution π = iCRT, where C is the molar concentration and i is the van't Hoff factor. If a pressure larger than the osmotic pressure is applied on the solution side, pure water is pushed out through the semipermeable membrane (often a film of cellulose acetate); this is reverse osmosis. The same idea matters in hospitals: a 0.9% (mass/volume) NaCl solution (normal saline) is isotonic with blood fluid, so it can be injected into veins safely.

(Take R = 0.083 L bar K^{-1} mol^{-1}; assume complete dissociation of salts.)

Answer the following questions:

(I) What will happen to red blood cells placed in a 0.5% (mass/volume) NaCl solution?

(A) They will shrink. (B) They will swell and may burst. (C) No change will occur. (D) They will first shrink and then swell.

(II) Sea water may be taken as 0.50 mol L^{-1} NaCl. The minimum pressure needed to desalinate it by reverse osmosis at 300 K is about:

(A) 12.45 bar (B) 2.49 bar (C) 24.9 bar (D) 49.8 bar

(IIIA) A well near Alibag contains 0.05 mol L^{-1} NaCl and 0.01 mol L^{-1} $MgCl_2$. Calculate the minimum pressure that the RO pump must apply at 300 K to obtain pure water from it.

OR

(IIIB) 1.0 g of an enzyme (a protein) extracted from raw papaya is dissolved in water to make 100 mL of solution. Its osmotic pressure at 300 K is 2.49×10^{-3} bar. Calculate the molar mass of the protein. Why is osmotic pressure preferred over other colligative properties for finding the molar masses of proteins?

30 A DNA model at a school science fair

Students in Nashik prepared a model of a short double-stranded DNA segment for their school science fair. They read that in DNA the two strands are held together by hydrogen bonds between specific pairs of bases: adenine (A) always pairs with thymine (T), and guanine (G) always pairs with cytosine (C). Each nucleotide unit contains one base, one β-D-2-deoxyribose sugar and one phosphate group. A laboratory report showed that in a sample of double-stranded DNA from a soil bacterium, cytosine makes up 18% of all the bases.

Answer the following questions:

(I) The percentage of adenine in this bacterial DNA is:

(A) 18% (B) 32% (C) 36% (D) 64%

(II) To change their DNA model into a model of RNA, the students must:

(A) replace deoxyribose by ribose and thymine by uracil

(B) replace deoxyribose by ribose and adenine by uracil

(C) replace ribose by deoxyribose and cytosine by uracil

(D) replace only thymine by uracil, keeping the same sugar

(IIIA) One strand of the model has the base sequence A–T–T–G–C–A–C. Write the base sequence of the complementary strand, base by base. How many purine bases (adenine and guanine) are present in this double-stranded segment in all?

OR

(IIIB) The complete model has 20 base pairs, of which 8 are G–C pairs. How many (a) adenine bases, (b) cytosine bases, (c) deoxyribose units and (d) phosphate groups are present in the model?

SECTION E Questions 31 to 33 are long answer questions carrying 5 marks each. **[15]**

31 (A) (I) An organic compound A (C_4H_8O) forms a crystalline addition compound with sodium hydrogensulphite but gives no red precipitate when warmed with Fehling's solution. Reduction of A with sodium borohydride gives an alcohol B whose molecule has a chiral carbon atom. Identify A and B, and write the equations for the reaction of A with (a) iodine and sodium hydroxide, (b) HCN and (c) hydrazine followed by heating with KOH in ethylene glycol.

(II) Why are the α-hydrogen atoms of aldehydes acidic? Write the structure and IUPAC name of the aldol formed from propanal in the presence of dilute NaOH and of the product formed when this aldol is heated.

OR

(B) (I) Account for the following:

(a) Methanal does not undergo aldol condensation but undergoes Cannizzaro reaction.

(b) Electrophilic substitution in benzoic acid takes place at the meta position.

(c) Aldehydes are oxidised even by mild oxidising agents, whereas ketones need strong oxidising agents and drastic conditions.

(II) How will you bring about the following conversions? Write the equations.

(a) Propanenitrile to propanal (b) Benzene to acetophenone

32 (A) Answer the following:

(I) Write the IUPAC name of $[Co(en)_2(H_2O)Cl]SO_4$.

(II) Write the formula of pentaamminethiocyanato-S-chromium(III) chloride.

(III) Using valence bond theory, predict the hybridisation, shape and magnetic behaviour (number of unpaired electrons and spin-only magnetic moment) of the tetrahedral complex ion $[CoCl_4]^{2-}$. (Co: Z = 27)

(IV) Write the formula and IUPAC name of the linkage isomer of the compound in (II).

OR

(B) Answer the following:

(I) Using crystal field theory, explain why $[Co(en)_3]^{3+}$ is diamagnetic whereas $[CoF_6]^{3-}$ is paramagnetic. Draw the d-orbital splitting diagrams. (Co: Z = 27)

(II) How many geometrical isomers are possible for the octahedral complex ion $[Cr(H_2O)_4Cl_2]^+$? Name them.

(III) $[Ni(en)_3]^{2+}$ is more stable than $[Ni(NH_3)_6]^{2+}$. Give reason.

(IV) Write the oxidation number and coordination number of the central metal in $K_2[Ni(C_2O_4)_2]$.

33 (A) (I) The conductivity of a 0.010 mol L^{-1} solution of propanoic acid at 298 K is 1.40×10^{-4} S cm^{-1}. Calculate (a) its molar conductivity, (b) its degree of dissociation and (c) its dissociation constant. Given: $\lambda°(H^+) = 349.6$ S cm^2 mol^{-1}, $\lambda°(CH_3CH_2COO^-) = 35.8$ S cm^2 mol^{-1}.

(II) Write the reactions taking place at the anode and the cathode of the mercury cell used in hearing aids and watches. Why does its cell potential stay nearly constant (about 1.35 V) during its life?

OR

(B) (I) A steel spoon is to be silver-plated in a small workshop in Pune. A current of 0.50 A is passed through $AgNO_3$ solution for 32 minutes 10 seconds. Calculate the mass of silver deposited on the spoon. (Ag = 108 g mol^{-1}, F = 96500 C mol^{-1})

(II) Write the anode and cathode reactions in the rusting of iron. How does coating iron with zinc (galvanisation) protect it even when the coating is scratched?

(III) The molar conductivity of a strong electrolyte increases slightly on dilution. Why?

All the best for your exam!